INDOOR AIR QUALITY ASSESSMENT

Department of Social Services
100 North Front Street
New Bedford, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Emergency Response/Indoor Air Quality Program
June 2007

Background/Introduction

In response to a request from Doug Shatkin, Human Resources Director, Office of Children, Youth & Families, Executive Office of Health and Human Resources (EOHHS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH), provided assistance and consultation regarding indoor air quality concerns at the Massachusetts Department of Social Services (DSS) located at 100 North Front Street, New Bedford, Massachusetts. The request was prompted by occupant symptoms (e.g., eye irritation, headaches, pneumonia, coughing, wheezing, congestion and exacerbation of asthma) that are believed to be related to poor indoor air quality (IAQ) in the building. One occupant in an interior office has been diagnosed with chronic dry eye syndrome.

On April 26, 2007, an indoor air quality assessment was conducted at the DSS by Cory Holmes, an Environmental Analyst in BEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied for portions of the assessment by Marlene Centeio, Business Manager, DSS.

The DSS offices are located on the 1st and 2nd floors of an old red brick building originally constructed as a factory in the early 1900s. The building has undergone interior renovations over the years and currently houses a number of state offices and private businesses. The DSS has occupied this building since 2000. The space consists of offices, open work areas and conference rooms. Windows are not openable on the 1st floor but are openable in some areas of the 2nd floor occupied by DSS.

Due to previous IAQ concerns among DSS staff, the Massachusetts Department of Labor and Workforce Development (MDLWD), Division of Occupational Safety (DOS) conducted an IAQ inspection in August of 2001. The 2001 DOS report recommended: (1)

locating and repairing all sources of water leakage (i.e., windows, foundation, roof and HVAC); (2) removal of all water-damaged carpets and ceiling tiles; (3) removal of plaster walls below leaking windows to observe wall cavities for mold contamination, repair and decontamination as needed; (4) removal of loose/rotted wood from eave outside electrical room-repair area; (5) steam cleaning/shampooing of carpeting at least twice a year (or as indicated in lease); (6) inspection and repair of wall in Guarino unit to eliminate drafts; (7) re-location of supply and/or return in Isabel office to increase the distance between them; (8) have HVAC system evaluated by a qualified ventilation firm to assure proper function (e.g., at least 15 % outside air and 20 CFM of outside air per person); (9) develop and implement an IAQ management plan (MDLWD, 2001).

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor. BEH staff also performed a visual inspection of building materials for water damage and/or microbial growth. Moisture content of porous building materials (i.e., wood, gypsum wallboard and carpeting), were measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The DSS has an employee population of approximately 140 and is visited by up to 50 individuals daily. Tests were taken during normal operations. Results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million (ppm) in forty-three of fifty-three areas surveyed, indicating poor air exchange in the majority of areas surveyed during the assessment. Mechanical ventilation is provided by air-handling units (AHUs) located on the rooftop or on the exterior of the building (Pictures 1 and 2). Fresh air is drawn into the AHUs and delivered to occupied areas via ceiling-mounted air diffusers (Picture 3). Return air is drawn into ceiling-mounted grates (Picture 4) into an above ceiling plenum where it is ducted back to the AHUs.

Thermostats control each heating, ventilating and air conditioning (HVAC) system. Thermostats have fan settings of "on" and "automatic". Thermostats had been set to the "automatic" setting in areas surveyed during the assessment (Picture 5). The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once a preset temperature is measured by the thermostat, the HVAC system is deactivated. Therefore no mechanical ventilation is provided until the thermostat re-activates the system. Without dilution and removal by the mechanical ventilation system, commonly occurring indoor air pollutants can build up and lead to indoor air quality/comfort complaints. This was the case in the area of the DSS where the staff member was experiencing discomfort due to chronic dry eye syndrome. To provide air circulation a personal fan was being used in this office, however the movement of air from the fan may create air currents which can further dry out eyes and exacerbate irritation.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to

provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings ranged from 72° F to 78 ° F, which were within the MDPH recommended comfort guidelines in all areas surveyed during the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. Temperature control and poor airflow complaints were expressed in several areas. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 34 to 43 percent, which for the most part was within or close to the lower end of the MDPH recommended comfort range the day of the assessment. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is common during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As indicated in the previous IAQ report provided by DOS, the building has experienced damage due to water infiltration from a number of sources (MDLWD, 2001). Identification and elimination of water moistening building materials is necessary to control mold growth (in this case leaks through the building envelope). Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. All water damaged porous materials tested were found to have low (i.e., normal) moisture content (Table 1) at the time of the assessment. However, it is important to note that moisture content of materials is a real-time measurement of the conditions present in the building at the time of the assessment.

Several occupants reported chronic water pooling directly outside of the building and described conditions of having to walk through accumulated water to get inside the building. It was reported that some attempts have been made to mitigate water infiltration such as roof repairs and more recently the installation of an asphalt berm (Picture 6) to divert water away from the building. Despite these efforts, evidence of water infiltration in the form of stained carpeting, stained/damaged/missing ceiling tiles, peeling paint and damaged gypsum wallboard (GW) were observed (Pictures 7 and 8). Several areas either had carpeting replaced or were scheduled to be replaced at the time of the assessment.

Repeated water damage to porous building materials (e.g., carpeting) can result in microbial growth. The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed.

Missing/damaged mortar around the exterior of the building was observed in a number of areas, which can provide a source of water penetration (Pictures 9 and 10). A section of the roof eave was missing on the rear of the building (Pictures 11 and 12), which corresponded to water damaged areas on the interior of the DSS. Water staining down the side of the building and heavy moss growth was observed at the base of the exterior wall directly below this area indicating chronic wetting/water pooling.

Plants were observed in several areas. Plants should be properly maintained and equipped with drip pans. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on porous materials, since water damage to porous materials may lead to microbial growth.

Water coolers were observed on carpeting (Picture 13). Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. In addition, some of the coolers had residue/build-up in the reservoir. These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

Other IAQ Evaluations

The amount of materials stored inside offices and common areas (Picture 14) should be noted. In areas throughout the building, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored provides a source for dusts to accumulate. These items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Finally, AHUs are normally equipped with filters that strain particulates from airflow. Filters for AHUs were not accessible at the time of the BEH assessment. However the thermostat for the HVAC system on the second floor had a "filter checkup recommendation" light that was illuminated at the time of the assessment, which may indicate that filters need attention/changing. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop), which can subsequently reduce the efficiency of the AHU due to increased resistance. Prior to any increase of filtration, each

AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

Conclusions/Recommendations

At the time of the BEH assessment, some steps had been taken to reduce water penetration into the building, however, based on occupant reports of current leaks and the prevalence of water damaged materials observed by BEH staff during the assessment further attention is needed. Reports of eye irritation by the occupant with chronic dry eye syndrome can be exacerbated by a number of factors typical to any office environment such as low relative humidity. In addition, the use of a portable fan in a small office can create further irritation by disturbing settled dust and creating air currents that can dry the eyes. Further complicating this condition is the typical recommendation by BEH to operate the HVAC system in the fan "on" mode to provide *continuous* ventilation when the offices are occupied. As previously discussed, the HVAC system in this area was operating intermittently at the time of the BEH assessment. Although the continuous operation of the HVAC system is recommended to increase air exchange, this action may exacerbate eye irritation symptoms of this particular occupant. For this reason, the recommendations are separated into two categories: General Indoor Air Quality Recommendations and recommendations specific to office 106.

In view of these findings at the time of the visit, the following recommendations are made to improve **General Indoor Air Quality**:

1. Operate ventilation systems in the fan "on" mode to provide continuous air circulation during periods of occupancy.

2. Consult a ventilation engineer concerning the need to increase the percentage of fresh air supplied by the HVAC as a means to improve air exchange.
3. Supplement airflow by using openable windows (where able) to control for comfort (with the exception of during the cooling season when AC is activated). Care should be taken to ensure windows are properly closed at night and weekends to avoid freezing of pipes and potential flooding.
4. Consider balancing mechanical ventilation systems every 5 years, as recommended by ventilation industrial standards (SMACNA, 1994).
5. Change filters for HVAC equipment as per the manufacture's instructions or more frequently if needed. Consider installing filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent, MERV rating of 9. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

7. Continue to repair any water leaks as they may occur, and replace any remaining water damaged ceiling tiles. Examine the areas above and behind these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
8. Make repairs/alterations to the damaged roof shown in Pictures 11 and 12 to provide drainage and to prevent water infiltration/pooling against the building.
9. Repair missing/damaged mortar in exterior walls to prevent water penetration, drafts and pest entry.
10. Continue with plans to remove water damaged carpeting. Consider installing a water-impermeable floor covering (e.g., tile) in areas susceptible to water penetration to prevent mold growth.
11. Make repairs/replace water damaged GW.
12. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
13. Relocate or place tile or rubber matting underneath water coolers in carpeted areas. Clean and disinfect reservoirs as needed to prevent microbial growth.
14. Continue to examine methods to improve drainage around the building to prevent water pooling/infiltration. Consider contacting a building engineer or professional drainage/landscaping firm to examine other potential remediation/prevention strategies.
15. Relocate or consider reducing the amount of materials stored in offices and common areas to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
16. Clean air diffusers, return and exhaust vents periodically of accumulated dust.

17. Consider cleaning carpeting annually (or semi-annually in soiled high traffic areas) as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)

18. For additional information on mold refer to "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). This document is available from the US EPA website: http://www.epa.gov/iaq/molds/mold_remediation.html.

19. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://mass.gov/dph/indoor_air.

Recommendations for Office 106

1. Consider relocating occupant with chronic dry eye syndrome to an area with an openable window to provide for better air exchange.
2. Although the BEH does not generally advocate the use of humidification equipment (portable humidifiers), the occupant diagnosed with chronic dry eye syndrome may want to consider the use of such equipment. However, if a portable humidifier is to be used, it is recommended that it be emptied/cleaned regularly, as per the manufacturer's instructions (or more frequently if needed) to prevent microbial and/or bacterial growth.

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Picture 1

Rooftop AHUs

Picture 2

AHUs on Exterior of Building

Picture 3

Ceiling-Mounted Air Diffuser

Picture 4

Ceiling-Mounted Return Grate

Picture 5

Close-up of Thermostat

Picture 6

Asphalt Berm against Exterior Wall

Picture 7

Water Damaged Ceiling Tiles along Exterior Wall/Window Frame 2nd Floor

Picture 8

Water Damaged Ceiling Tiles and GW in Kitchen/Break Room Area

Picture 9

Missing/Damaged Mortar around Exterior Brick, Pen Inserted by BEH Staff to Show Depth

Picture 10

Missing/Damaged Mortar/Damaged Exterior Brick

Picture 11

Missing Section of Roof Eave at Rear of Building

Picture 12

Missing Section of Roof Eave at Rear of Building, Note Panels on Second Floor Window, Which may Provide a Pathway for Water Penetration

Picture 13

Water Cooler and Containers on Carpeting

Picture 14

Boxes and Other Items Stored in Common Hallway

Location: DSS Office **Indoor Air Results**

Address: 100 North Front St. Street, New Bedford, MA **Table 1** **Date: 4/26/2007**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	413	48	48					Mostly sunny
2nd Floor								
Barbosa	649	75	40	0	N	Y	N	
Celia's Unit	676	76	39	4	N	Y	Y	
Pitnof	660	76	38	0	N	Y	Y	
Marcalo	730	77	39	0	N	Y	N	
Conference Room	639	77	36	0	Y	Y	N	
Couto Unit	709	77	36	1	N	Y	N	
Couto	725	77	36	1	N	Y	N	
Donahue	704	78	36	1	N	Y	N	
Donahue Unit	746	78	36	3	Y	Y	Y	
Mendes	693	78	34	0	N	Y	N	

ppm = parts per million

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: DSS Office **Indoor Air Results**

Address: 100 North Front St. Street, New Bedford, MA **Table 1 (continued)** **Date: 4/26/2007**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Mendes Unit	827	78	36	3	N	Y	Y	
Perry Unit	901	78	35	2	Y	Y	Y	8 WD CTs
Perry	964	78	35	1	Y	Y	Y	
Adoption Unit	921	76	34	2	Y	Y	N	Ventilation off
Paquette	919	76	34	1	Y	Y	Y	Ventilation off
Hendrik	929	76	35	1	N	Y	Y	
Sylvia	999	75	35	0	N	Y	Y	Ventilation off
Law Office	1008	75	36	0	N	Y	Y	Ventilation off
Frieburger	1101	75	37	1	N	Y	Y	Ventilation off
Frieburger Unit	1055	75	38	0	Y	Y	Y	Ventilation off
1st Floor								

ppm = parts per million, WD = water damage, CT = ceiling tiles

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Location: DSS Office **Indoor Air Results**

Address: 100 North Front St. Street, New Bedford, MA **Table 1 (continued)** **Date: 4/26/2007**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Front Desk	1046	74	38	1	N	Y	Y	
Conference Room A	1049	74	39	0	N	Y	Y	
Family Network	1025	74	40	4	N	Y	Y	
Visitors Unit	1060	74	40	3	N	Y	Y	1 WD CT/GW chronic leak (corner), low/normal moisture reading
Kitchen					N	Y	Y	
Bell	1063	73	41	0	N	Y	Y	
Porche´	1032	75	42	1	N	Y	Y	Portable heater in use
Kennedy	958	74	41	0	N	Y	Y	
Unit B	1016	74	41	2	N	Y	Y	Carpet WD-replaced, plants
Owen	974	73	41	0	N	Y	Y	Carpet WD-low/normal moisture, new carpet reportedly “on order”, air freshener
Bell Intake Unit	1069	74	42	2	N	Y	Y	

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Location: DSS Office **Indoor Air Results**

Address: 100 North Front St. Street, New Bedford, MA **Table 1 (continued)** **Date: 4/26/2007**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Kennedy Intake Unit	1109	75	42	2	N	Y	Y	
Isabel	1200	75	42	1	N	Y	Y	Personal fan-on, ventilation-off
Isabel Intake Unit	1166	75	41	0	N	Y	Y	Ventilation off
Moore Ongoing	1126	75	41	1	N	Y	Y	
Moore	1102	75	41	0	N	Y	Y	
Trembly Intake	1161	75	40	1	N	Y	Y	
Trembly	1108	75	40	0	N	Y	Y	
Silvia	1225	75	41	3	N	Y	Y	
Silvia Ongoing	1238	75	41	0	N	Y	Y	
Protective Assessment	1108	75	42	2	N	Y	Y	Water penetration through wall, carpet low/normal moisture
Albernez	1066	75	41	0	N	Y	Y	

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Location: DSS Office **Indoor Air Results**

Address: 100 North Front St. Street, New Bedford, MA **Table 1 (continued)** **Date: 4/26/2007**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Adolescent Unit	1095	74	40	2	N	Y	Y	
Oliver	1169	74	40	0	N	Y	Y	
Gagnon	1219	75	41	2	N	Y	Y	
Conference Room B	1088	74	40	0	N	Y	Y	
G-Unit	1180	74	40	4	N	Y	Y	
Gonzalez	1201	74	41	0	N	Y	Y	
Family Resource	1130	74	41	4	N	Y	Y	Plants
Mello	1065	73	40	0	N	Y	Y	2 WD CT
Dennis Conference Room	1020	73	42	0	N	Y	Y	
Lebeau	1021	72	42	1	N	Y	Y	
Gauthier	1025	72	42	0	N	Y	Y	

ppm = parts per million, WD = water damage, CT = ceiling tiles

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Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Centeio	1018	72	43	0	N	Y	Y	

ppm = parts per million, WD = water damage, CT = ceiling tiles

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	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
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